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Building technology entrepreneurship capabilities, an engineering education perspective.

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Much has been discussed on the changing role of universities in society, in particular when examining the contribution of universities in the economic growth and societal development (Audretsch 2012). The transition from universities as research centers to universities as innovation drivers has left many co-existing models in place (Schmitz et al. 2016), making it difficult to identify and articulate valid response mechanisms to new societal challenges.

The demand to respond to societal challenges contrasts with the research-focused nature of most of the universities, that has traditionally left the role of technology innovation and entrepreneurship to other agents. Thus, the function of science and technology commercialization has often required the activation of specific actors such as Technology Transfer Offices (TTOs) linked to the government, universities, or research centers (Fitzgerald and Cunningham 2015). Prior research has identified the existent constraints to activate academic engagement, highlighting the distance between science and technology research activities with industry related innovation and entrepreneurship initiatives (Perkmann et al. 2013).

An alternative path to respond to the divergence between the new demands imposed by the societal challenges and the existing science and technology development focus of universities is to transform the educational programs being offered. Instead of aiming to transform consolidated structures through directed interventions, such as entrepreneurship incentives for established researchers; the attention would be given on building the student's skills and capabilities for technology entrepreneurship and innovation.

To study this alternative path, we explore the case of two European universities. Prior research has observed, compared to the USA, that in the European context there have been additional challenges and difficulties for successful academic entrepreneurship in the form of university spin-offs (Fini et al. 2016). Therefore, the exploration of alternative paths or mechanisms to promote technology entrepreneurship could be particularly relevant. We identified the engineering programs of two universities based in France and Denmark, these two cases serve the purpose of identifying responses

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to the demand of activating science and technology education with a focus on activating science-based entrepreneurial activity.

The two cases of science and technology entrepreneurship education (STEE) share common elements, for instance there are similarities on the overall design, content, pedagogical methods, learning environment, and intended learning outcomes. Nevertheless, each program has specific elements related to outcomes assessment and to their integration processes with the regional actors. A comparative analysis of the two cases provides insights on potential guidelines to structure programs that foster technology entrepreneurship through education and training.

Both programs, one at Lorraine University (UL) in France and the other at University of Southern Denmark (SDU) in Denmark, were developed as a response to a strong demand in their region for professionals with an entrepreneurial mindset and engineering capacities. The regional actors see the universities as a collaborative partner for research and education in the field of science and technology. The strong connection with the region's industry becomes an influencing factor on the design and implementation of the STEE.

The overall theme for the pedagogical model in UL and SDU is organized around the student-subject-project triangle. Supporting problem-based learning is the preferred approach. In more detail, the DSMI model (acronym for *Den Syddanske Model for Ingeniøruddannelser*) used at SDU requires that students work on problems proposed by companies in the region during their studies, introducing company visits and participation of company employees as guest lectures as part of the regular course activities.

The development of attitudes towards entrepreneurial behavior is also activated through internal projects. For instance, as part of a master program, engineering students enroll in a business venturing course (the course receives different names in each institution), where researchers from the university pitch their ongoing projects, involving the TTO if necessary, to the students. The course offers a safe environment to put in practice technology commercialization practices through a real case exercise; although the learning outcomes of the course are focused on analyzing and applying methods, the real-life outcomes have been the creation of student-lead start-ups in the region.

A significant catalyzer of the technology entrepreneurship education for both programs has been the creation of a specific learning environment. In the case of UL it has been the creation of Lorraine Fab Living Lab, and at SDU the Innovation Lab facility. These innovation spaces become a centerpiece of the training programs as they have different properties compared to other engineering or research labs. Instead of replicating industry labs at a smaller scale, they are a tangible representation of the often-

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abstract entrepreneurship process. The intense use of these facilities in the educational programs aim to modify the self-efficacy perception of the students regarding the entrepreneurial behavior.

The aim of this paper is to provide illustrative examples that can be used as a guide to propose alternative paths to activate technology entrepreneurship. The cases of the engineering programs at two European universities are used to identify the common and specific elements that configure a response to the societal demands to the universities.

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